CLAIMS

1. A method of monitoring fluid flow comprising:

providing an optical fibre having a heatable coating;

disposing the optical fibre so that the heatable coating is in thermal contact with flowing fluid;

heating the heatable coating so that heat is transferred from the coating to the fluid;

launching light into the optical fibre;

detecting light from the optical fibre;

processing the detected light to obtain information indicative of the temperature of the heatable coating, where the temperature of the heatable coating depends on the flow; and

using the information indicative of the temperature of the heatable coating to derive information about the flow.

2. A method according to claim 1, in which the temperature of the heatable coating depends on the rate of flow or flow velocity, and the information indicative of the temperature of the heatable coating is used to derive information about the rate of flow or flow velocity.

3. A method according to claim 1, in which the temperature of the heatable coating depends on the type of fluid, and the information indicative of the temperature of the heatable coating is used to derive information about the type of fluid.

4. A method according to any one of claims 1 to 3, in which the heatable coating is provided as a layer around the outer surface of the optical fibre extending axially along the optical fibre.

5. A method according to claim 4, in which the heatable coating comprises electrically resistive material, and the heatable coating is heated by passing electric current through the coating.

6. A method according to claim 5, in which the optical fibre is further provided with an electrically insulating coating covering the heatable coating.

7. A method according to claim 4, in which the heatable coating comprises optically absorbing material, and the heatable coating is heated by exposing the heatable coating to light at a wavelength that is absorbed by the optically absorbing material.

8. A method according to claim 7, in which the heatable coating is exposed by injecting light at a wavelength that is absorbed by the optically absorbing material into cladding of the optical fibre.

9. A method according to any one of claims 4 to 8, in which the launching light, detecting light and processing the detected light comprises operating the optical fibre as a distributed temperature sensor.

10. A method according to claim 9, comprising using the information indicative of the temperature of the heatable coating to derive information about the composition of the fluid.

11. A method according to claim 10, in which the information about the composition of the fluid includes at least one of the oil content, the gas content and the water content of fluid flowing in an oil well.

12. A method according to any one of claims 9 to 11, in which the using the information indicative of the temperature of the heatable coating to derive information about the flow comprises identifying changes in temperature along the length of the fibre, such a change indicating the location of a change in the flow of the fluid.

13. A method according to claim 1, in which the launching light, detecting light and processing light comprises operating the optical fibre as a distributed temperature sensor, and the using the information indicative of the temperature of the heatable coating to derive information about the flow comprises identifying changes in temperature along the length of the fibre, such a change indicating the location of a change in the flow of the fluid.

14. A method according to claim 12 or claim 13, in which the identifying changes in temperature comprises locating positions of inflow or outflow of fluid in the vicinity of the optical fibre.

15. A method according to claim 14, in which the monitoring fluid flow comprises locating leaks, in which:

the optical fibre is disposed within a leaking pipe; and the method further comprises, before heating the heatable coating:

allowing fluid to flow into the pipe; and

any change identified is an increase in temperature with respect to the direction of fluid flow, caused by a decreased flow of the fluid after the position of a leak.

16. A method according to claim 12 or claim 13, in which the identifying changes in temperature comprises locating positions of any constrictions in flow.

17. A method according to any one of claims 1 to 3, in which the heatable coating is provided on a distal end facet of the optical fibre.

18. A method according to claim 17, in which the heatable coating comprises optically absorbing material, and the heatable coating is heated by exposing the heatable coating to light at a wavelength that is absorbed by the optically absorbing material.

19. A method according to claim 18, in which the heatable coating is exposed by injecting light at a wavelength that is absorbed by the optically absorbing material into a proximal end of the optical fibre.

20. A method according to any one of claims 17 to 19, in which launching light into the optical fibre comprises launching the light into the proximal end of the optical fibre, the light having a wavelength such that it is reflected from the heatable coating.

21. A method according to claim 20, in which the processing the detected light comprises measuring the amount of detected light reflected from the heatable coating and using this information to obtain information relating to the temperature of the heatable coating.

22. A method according to claim 20, in which the processing the detected light comprises measuring the amount of detected light reflected from the heatable coating and using this to obtain information relating to the optical thickness of the heatable coating, where the optical thickness of the heatable coating depends on its temperature.

23. A method according to any one of claims 17 to 22, in which the heatable coating is provided as a single layer.

24. A method according to any one of claims 17 to 22, in which the heatable coating is provided as two layers, one layer being optically absorptive and one layer being opticallydependent on temperature.

25. A method according to any preceding claim, in which the optical fibre is disposed within a well bore.

26. Apparatus for monitoring fluid flow, comprising:

an optical fibre having a heatable coating for disposing in thermal contact with flowing fluid;

a power source operable to heat the heatable coating so that heat is transferred from the coating to the fluid;

an optical source operable to generate light and launch the light into the optical fibre;

a photodetector operable to detect light from the optical fibre; and

a processor operable to process the detected light to obtain information indicative of the temperature of the heatable coating, where the temperature of the heatable coating depends on the flow.

27. Apparatus according to claim 26, in which the processor is further operable to derive information about the flow from the information indicative of the temperature of the heatable coating.

28. Apparatus according to claim 27, in which the temperature of the heatable coating depends on the rate of flow or flow velocity, and the processor is operable to

derive information about the rate of flow or flow velocity from the information indicative of the temperature of the heatable coating.

29. Apparatus according to claim 27, in which the temperature of the heatable coating depends on the type of fluid, and the processor is operable to derive information about the type of fluid from the information indicative of the temperature of the heatable coating.

30. Apparatus according to any one of claims 26 to 29, in which the heatable coating is provided as a layer around the outer surface of the optical fibre extending axially along the optical fibre.

31. Apparatus according to claim 30, in which the heatable coating comprises electrically resistive material, and the power source is an electrical power source operable to heat the heatable coating by passing electric current through the coating.

32. Apparatus according to claim 31, in which the optical fibre is further provided with an electrically insulating coating covering the heatable coating.

33. Apparatus according to claim 30, in which the heatable coating comprises optically absorbing material, and the power source is an optical power source operable to heat the heatable coating by exposing the heatable coating to light at a wavelength that is absorbed by the optically absorbing material.

34. Apparatus according to claim 33, in which the optical power source is operable to inject light at a wavelength that is absorbed by the optically absorbing material into cladding of the optical fibre.

35. Apparatus according to any one of claims 29 to 34, in which the optical source, the photodetector and the processor are operable to enable operation of the optical fibre as a distributed temperature sensor.

36. Apparatus according to claim 35, in which the processor is operable to derive information about the composition of the fluid from the information indicative of the temperature of the heatable coating.

37. Apparatus according to claim 36, in which the information about the composition of the fluid includes at least one of the oil content, the gas content and the water content of fluid flowing in an oil well.

38. Apparatus according to any one of claims 35 to 37, in which the processor is further operable to use the information indicative of the temperature of the heatable coating to derive information about the flow by identifying changes in temperature along the length of the fibre, such a change indicating the location of a change in the flow of the fluid.

39. Apparatus according to claim 26, in which the optical source, the photodetector and the processor are operable to enable operation of the optical fibre as a distributed temperature sensor, and the processor is further operable to use the information indicative of the temperature of the heatable coating to derive information about the flow by identifying changes in temperature along the length of the fibre, such a change indicating the location of a change in the flow of the fluid.

40. Apparatus according to claim 38 or claim 39, in which the identifying changes in temperatures comprises locating positions of inflow or outflow of fluid in the vicinity of the optical fibre.

41. Apparatus according to claim 40, and operable to locate leaks, in which:

the flowing fluid flows within a leaking pipe; and the apparatus further comprises:

a pump operable to pump fluid into the pipe; and

the processor is further operable to identify any change increase in temperature with respect to the direction of fluid flow, caused by a decreased flow of the fluid after the position of a leak.

42. Apparatus according to claim 38 or claim 39, in which the identifying changes in temperature comprises locating positions of any constrictions in flow.

43. Apparatus according to any one of claims 26 to 29, in which the heatable coating is provided on an end facet at a distal end of the optical fibre.

44. Apparatus according to claim 43, in which the heatable coating comprises optically absorbing material, and power source is an optical power source operable to heat the heatable coating by exposing the heatable coating to light at a wavelength that is absorbed by the optically absorbing material.

45. Apparatus according to claim 44, in which the optical power source is operable to inject light at a wavelength that is absorbed by the optically absorbing material into a proximal end of the optical fibre.

46. Apparatus according to any one of claims 43 to 45, in which the optical source is operable to launch light having a wavelength such that it is reflected from the heatable coating into a proximal end of the optical fibre.

47. Apparatus according to claim 46, in which the processor is operable to measure the amount of detected light reflected from the heatable coating and use this to obtain information relating to the temperature of the heatable coating.

48. Apparatus according to claim 46, in which the processor is operable to measure the amount of detected light reflected from the heatable coating and use this to obtain information relating to the optical thickness of the heatable coating, where the optical thickness of the heatable coating depends on its temperature.

49. Apparatus according to any one of claims 43 to 48, in which the heatable coating is provided as a single layer.

50. Apparatus according to any one of claims 43 to 48, in which the heatable coating is provided as two layers, one layer being optically absorptive and one layer being optically dependent on temperature.

51. Apparatus according to any one of claims 26 to 50, wherein the optical fibre is deployed within a well bore.

52. A method of monitoring fluid flow in an oil well, comprising:

providing an optical fibre having a heatable coating;

deploying the optical fibre downhole in an oil well such that the heatable coating is in thermal contact with flowing fluid;

heating the heatable coating so that heat is transferred from the coating to the fluid;

launching light into the optical fibre;

detecting light from the optical fibre;

processing the detected light to obtain information indicative of the temperature of the heatable coating, where the temperature of the heatable coating depends on the flow; and

using the information indicative of the temperature of the heatable coating to derive information about the flow.

53. A method according to claim 51, in which the heatable coating is provided as a layer around the outer surface of the optical fibre extending axially along the optical fibre.

54. A method according to claim 53, in which the launching light, detecting light and processing the detected light is performed so as to obtain the information indicative of the temperature of the heatable coating in the form of a distributed temperature profile over the length of the optical fibre.

55. A method according to any one of claims 51 to 54, in which the using the information indicative of the temperature of the heatable coating to derive information about the flow comprises identifying changes in temperature with depth within the well bore, such a change indicating the location of a change in the flow of the fluid.

56. A method according to claim 55, in which the identifying changes in temperature comprises locating any constriction in the flow that causes an increase in the flow of the fluid.

57. A method according to claim 56, in which the locating any constriction in the flow comprises locating any deposit of scale within the well bore.

58. A method according to any one of claims 52 to 57, and further comprising using the information indicative of the temperature of the heatable coating to derive information about the composition of the fluid.

59. A method according to claim 58, in which the information about the composition of the fluid includes at least one of the oil content, the gas content and the water content of the fluid.

60. A method of detecting scale within a well bore, comprising:

providing an optical fibre having a heatable coating;

deploying the optical fibre downhole within a well bore so that the heatable coating is in thermal contact with fluid flowing within the well bore;

heating the heatable coating so that heat is transferred from the coating to the fluid;

launching light into the optical fibre;

detecting light from the optical fibre;

processing the detected light to obtain information indicative of any variation in temperature of the heatable coating with depth within the well bore, where the temperature of the heatable coating depends on the flow of the fluid;

monitoring the temperature information for any changes in temperature of the heatable coating with depth within the well bore; and

identifying any change in temperature with a change in fluid flow within the well bore caused by scale deposition at that depth.

61. A method of monitoring fluid flow substantially as described herein with reference to the accompanying drawings.

62. Apparatus for monitoring fluid flow subtantially as described herein with reference to the accompanying drawings.

63. A method of monitoring fluid flow in an oil well substantially as described herein with reference to the accompanying drawings.

64. A method of detecting scale within a well bore, substantially as described herein with reference to the accompanying drawings.